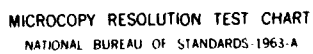END
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INITIAL PROVISIONING/INITIAL SPARES:
A QUESTION OF SEMANTICS AND COST

MARK W. GLENN, OPERATIONS RESEARCH ANALYST

JUNE 1983

FINAL REPORT

US ARMY AVIATION RESEARCH AND DEVELOPMENT COMMAND
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a. The terms initial provisioning and initial spares are often used inter-
changeably. However, repeated experience has shown that they result in very
different cost estimates, with initial spares estimates usually being much
larger. A review of cost estimates, their underlying mathematics, and initial
provisioning and initial spares literature leads to the conclusion that initial
provisioning and initial spares are two different concepts. Initial provisioning
is a concept used in the logistics and budget community; initial spares is a
concept used in the cost analysis community. There is a disconnect between

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20a. Abstract (Continued).

logistics and budget on the one hand, and cost analysis on the other in this area. The purpose of this report is to surface and explain this disconnect and to identify possible methods of ending it.

b. This study will explain both concepts and develop a conceptual framework which is suitable for logistics, budget and life cycle cost estimating. The conceptual framework is designed to highlight the similarities and especially the differences between initial provisioning and initial spares. It is an integrated analysis--in two ways: logistics and cost analysis perspectives are integrated; Investment costs and Operating and Support (O&S) costs are integrated, so that life cycle costs are properly represented.

c. Cost data pertaining to particular weapon systems are historical in nature. In most cases, these cost estimates have been superseded. They are only included to indicate the impact of different spares definitions and should not be used for any other purpose.

INITIAL PROVISIONING/INITIAL SPARES:

A QUESTION OF SEMANTICS AND COST

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A. The terms initial provisioning and initial spares are often used interchangeably. However, repeated experience has shown that they result in very different cost estimates, with initial spares estimates usually being much larger. A review of cost estimates, their underlying mathematics, and initial provisioning and initial spares literature leads to the conclusion that initial provisioning and initial spares are two different concepts. Initial provisioning is a concept used in the logistics and budget community; initial spares is a concept used in the cost analysis community. There is a disconnect between logistics and budget on the one hand, and cost analysis on the other. The purpose of this report is to surface and explain this disconnect and to identify possible methods of ending it.

B. This study will explain both concepts and develop a conceptual framework which is suitable for logistics, budget and life cycle cost estimating. The conceptual framework is designed to highlight the similarities and especially the differences between initial provisioning and initial spares. It is an integrated analysis—in two ways: logistics and cost analysis perspectives are integrated; Investment costs and Operating and Support (O&S) costs are integrated. The latter insures that life cycle costs are properly represented.

C. Cost data pertaining to particular weapon systems are historical in nature. In most cases, these cost estimates have been superseded. They are only included to indicate the impact of different spares definitions and should not be used for any other purpose.

II. THE PROBLEM.

A.   Estimates for spare and repair parts are used for three purposes: logistics, budget and life cycle cost estimating. Initial provisioning is designed for logistics and budget purposes, and its use is associated primarily with Readiness Commands. Initial spares is designed for life cycle cost estimates; its use is associated with Research and Development Commands.

B.   The presence of two concepts and their related methodologies produces, at a minimum, confusion. It can also lead to estimates that are too high or too low for their intended purpose or to estimates which are not properly time-phased. This can lead to over or under budgeting, excessive or inadequate stockage and life cycle cost estimates that are too high or too low. Another problem that can arise is that misleading comparisons may be made between materiel systems, possibly leading to sub-optional acquisition decisions. These problems may be caught and corrected further downstream but only with difficulty and loss of credibility.

III. INITIAL PROVISIONING/INITIAL SPARES: STANDARD DEFINITIONS AND PRELIMINARY DISCUSSION.

A. AR 700-18, Provisioning of U.S. Army Equipment [1] defines provisioning: "A management process for determining and acquiring the range and quantity of support items necessary to operate and maintain an end item of materiel for an initial period of service."

B. Initial provisioning is a management process. It includes a cost estimate and also includes the development of item records, publication of Technical Manuals and answers to such logistical questions as: Which items should be purchased, in what quantity, at what time and for stockage at which locations? In this report, I am only concerned with a time-phased initial provisioning cost estimate and the reason why it often differs from the time-phased initial spares cost estimate.

C. Initial Spares is shorthand for initial spare and repair parts. It is defined in DA PAM 11-3, Investment Cost Guide for Army Materiel Systems [2]: "Initial Spares and Repair Parts (2.09). This element includes cost of initial spare components, subassemblies, and repair parts used for replacement purpose in major end items of equipment during the early stages of production until the regular supply system (pipeline) is capable of providing the necessary support."

D. This report will continue the common practice of referring to initial spares and repair parts under the rubric, initial spares. The term "whole engine spares" is used literally and so does not include repair parts.

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IV. COST ANALYSIS EXPERIENCE. The distinctions that are of interest to us cannot be drawn from the standard, "official", definitions of initial provisioning and initial spares. It was cost analysis experience in this office which led to the belief that there were real and systematic differences between these concepts. A review of some of these experiences follows:

A. June 1980, CH-47 Modernization Program Baseline Cost Estimate (BCE) and Independent Cost Estimate (ICE).

1. The BCE [3] used the Bare Bones Standard Initial Provisioning (BBSIP) Model [4] to derive its estimate. At that time, it was mandatory that BBSIP be used for budget purposes. The model was operated by the Program Management Division and inputs were collected by the Logistics Management Division of the CH-47 Modernization Program (CH-47M) Program Manager's Office (PMO). The estimate for Alternative 4, the alternative selected at DSARC (III), was $78.9M in FY81 dollars. The initial spares estimate in the ICE [5] was $172.7M FY81 dollars. The initial provisioning cost estimate was 46 percent of the initial spares estimate. There were several alternatives but in all cases the initial provisioning estimate was substantially less than the initial spares estimate.

2. At the time, the terms initial provisioning and initial spares were considered to be nearly synonymous. In an effort to identify the source of the difference between estimates, it was discovered that the initial provisioning estimate ended two years after the Initial Operational Capability

FOOTNOTE: 1/ Cost data pertaining to particular weapon systems are historical in nature. In most cases, these cost estimates have been superseded. They are only included to indicate the impact of different spares definitions and should not be used for any other purpose.

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(IOC) date. The initial spares estimate continued throughout the CH-47 Modernization Program, 14 years.

B. October 1980, Life Cycle Cost Estimate (LCCE) for the Utility Tactical Transport Aircraft System (UTTAS) Cost and Operational Effectiveness Analysis (COEA). The UTTAS COEA [6] contained several helicopter systems. As noted on the validation sheet, an initial provisioning estimate was developed for the BLACK HAWK system but initial spares estimates were developed for all other systems. The initial provisioning estimate was far less than the initial spares estimates. To ascertain the impact of different methodologies, the BLACK HAWK initial provisioning estimate was compared to the BLACK HAWK initial spares estimate from the BLACK HAWK BCE (Sep 79) [7]. The initial provisioning estimate was about forty percent lower. It was noted that, except for whole engine spares, initial provisioning ended two years after the IOC date (IOC plus 2). The initial spares estimates continued throughout the production period of the relevant helicopter systems.

C. December 1980, BLACK HAWK Selected Acquisition Report (SAR). Initial spares estimates were developed for the BLACK HAWK BCE and ICE in 1979. With the deployment of BLACK HAWK helicopters, demand data started to accumulate in the Directorate for Materiel Management (DMM), TSARCOM. The BLACK HAWK PMO turned to DMM for revised spares estimates based on spares usage experience. DMM utilizes Standard Initial Provisioning (SIP) and, as a result, initial provisioning estimates were reflected in the December 80 (and subsequent) BLACK HAWK SARs [8]. As a direct result, the

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spares estimates dropped by approximately $168M in FY81 dollars. This is all

the more surprising as the SAR does not include stock fund funded spares.

The variance analysis explained that initial provisioning ended two years after

the IOC date (IOC+2) and that thereafter all spares, except whole engine

spares, were replenishment spares. Initial spares estimates continued

throughout the production/deployment period, 15 years.

    D. May 1981, Remotely Piloted Vehicle (RPV) ICE and Revised BCE.

There was an original BCE [9] and ICE [10] and a later joint effort to produce

an updated BCE [11]. The research for the original ICE and the revised BCE

form the basis of this research report. The revised BCE contained an initial

provisioning estimate for inclusion in the budget and an initial spares

estimate for life cycle cost estimating. There is room for many differences

in methodology between estimates for spare and repair parts. However, in this

case, I developed both estimates and they differed only in regard to their

underlying concept. Surprisingly, the initial provisioning estimate proved

to be larger than the initial spares estimate. The initial provisioning estimate

was $101.3M in FY82 dollars, and the initial spares estimate was $77.1M in

FY82 dollars. I will later show that this exception is a predictable result

of the relatively short production and deployment schedule (6 years) of the

RPV. We will return to this study later in the report.

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V.   SPARES: AN INTEGRATED ANALYSIS.

A.   Introduction:

1.   We will frequently refer to the following diagram:

PROCUREMENT OF SPARE AND REPAIR PARTS:

	Before IOC+2	After IOC+2
PIPELINE FILL	Cell I	Cell II
CONSUMPTION	Cell III	Cell IV

2.   This diagram expresses investment and Operating and Support (O&S) costs for spare and repair parts in four mutually exclusive and collectively exhaustive categories. The relative area of a cell has no connection with the relative cost for its associated category.

3.   It is easier to refer to a cell by its number than to describe it verbally. However, verbal descriptions of these categories are possible. Cell I can be described as procurement of spare and repair parts made before two years after the initial operational capability date (IOC+2). Cell III is similar but procurement is made to replace parts consumed rather than for pipeline fill. Cell II corresponds to Cell I, and Cell IV corresponds to Cell III except procurement is made after IOC+2 rather than before.

4. This diagram is a convenient tool for analyzing, expresing and summarizing relationships of concern to us. We will discuss the diagram from both cost analysis and a logistics perspectives. Probably the best place to start is with consumption of spare and repair parts, i.e., cells III and IV.

B. Cells III and IV, Consumption of Spare and Repair Parts.

1. As helicopters or other end items are operated, parts fail. Parts that fail are either replaced or repaired. Those parts that are replaced are either repaired later and returned to the Army inventory or they are beyond repair and are discarded. Ultimately all failures lead to repair or attrition. When an item is repaired, repair parts are used and the cost of repair parts should be charged.[2] New parts are required to replace attrited parts and the acquisition cost of the replacement parts should be charged.

2. By consumption we mean "using up". Failures lead to repair or attrition. In the former case, repair parts are consumed; in the latter case, the failed, non-repairable item is consumed. Total consumption of spare and repair parts is a function of end-item usage rate. Normally usage rate per end item is held constant so that total consumption becomes a function of the total number of end-items. Consumption occurs throughout the end-item's operating life, usually assumed to be 20 years in the case of helicopters. A yearly consumption estimate is a function of the cumulative number of end items fielded.

FOOTNOTE: [2] The cost of labor is charged elsewhere in life cycle cost estimates, namely, under depot labor (cost element code 3.031) and maintenance pay and allowance (3.012). These categories are defined in DA Pam 11-4 [12].

3. Cells III and IV, consumption of spare and repair parts, is similar to the cost analysis concept of replenishment spares. Actually, Cells III and IV equate to all spare and repair parts in the Operating and Support (O&S) category of life cycle cost estimates. This includes replenishment spares (cost element code 3.021) and depot materiel (3.032). Replenishment spares is the largest category. In this study, Cells III and IV will be considered identical to the cost analysis term replenishment spares. This is done for terminological simplicity and to enhance contrast with logistical concepts and terms.

4. The distinction between Cell III and Cell IV is easy to make although it may seem arbitrary at this point. Procurement must be made for spare and repair parts that are consumed. This procurement must be made in advance of actual consumption because several leadtimes are involved. Those spare and repair parts which are procured before IOC date plus two years are shown in Cell III, those after IOC date plus two years are shown in Cell IV. Procurement of Spare and Repair Parts:

	Before IOC+2	After IOC+2	Cost Analysis Terms
Pipeline Fill	Cell I	Cell II	
Consumption	Cell III	Cell IV	Replenishment Spares

C. Cells I and II, Pipeline Fill.

1. By *pipeline fill* we are referring to those spares and repair parts required to fill the supply pipeline. I find it easiest to explain the concept of a supply pipeline through analogy with another pipeline, e.g., an oil pipeline. It is obvious that if one expects to receive 100 barrels of oil per hour at one end of a pipeline, 100 barrels per hour must be input at the other end. However, the pipeline must be filled first. The volume of oil in the pipeline is a one time requirement for the period of time the pipeline is in use.

2. The situation is similar with the supply system. Helicopters, or other end items, are operated and this leads to the consumption of parts (Cells III and IV). The consumption of parts for a period of time is comparable to the rate of flow of oil through an oil pipeline. Here, too, the pipeline must be filled first. The length of the pipeline depends on such leadtime supply elements as order-ship-times and repair turnaround times. The width of the pipeline depends on the amount of parts consumed per period of time and such non-leadtime supply elements as safety level and operating level. Spare and repair parts will be tied-up in the pipeline as long as the pipeline is in use.

3. Although we may be straining our analogy, it is useful to think of the supply system as having loops and byways, rather than being one straight pipeline. Some items cannot be repaired, so that a failure leads to replacement with a new part. Other items can be repaired, hence repair turn-

around times come into play. In addition, some items can be repaired at any one of many echelons, which leads to a yet more complex pipeline. The supply pipeline is usually analyzed echelon by echelon.

4. Cells I and II represent procurement for pipeline fill. Total pipeline fill depends on the total number of end-items fielded. Yearly pipeline fill estimate is a function of the incremental number of end items fielded. This is in contrast with the time-phased consumption estimate which is a function of the cumulative number of end-items fielded. The reason for this is that pipeline fill is a one-time cost for each end-item. By contrast, consumption extends throughout an end-item's operating life.

5. Pipeline fill is identical to the cost analysis concept called initial spares (cost element code 2.09). Because there is an initial spares cost associated with each end-item, initial spares is viewed as part of the acquisition cost of the end item and is therefore included in the investment phase of life cycle cost estimates. With this perspective, it is easy to understand the common practice of applying an initial spares cost factor (a percentage) to the end-item production cost in order to obtain an initial spares estimate.

6. The supply pipeline discussed up to this point is primarily a retail pipeline because it includes supply elements applicable to the DOD retail supply system. These elements include operating levels, repair turn-around times and order-ship-times for echelons below depot. In addition, depot repair turnaround time (normally considered a wholesale supply element) is included.

7. The supply pipeline can be viewed more broadly so as to include wholesale elements. These include administrative leadtime (the time required to negotiate a production contract), production leadtime (the time required to produce the item), shipping time (from the contractor to the depot) and non-leadtime supply elements such as economic order quantity and safety level. In fact the wholesale pipeline is much larger than the retail pipeline - approximately 24 months as opposed to at most 6 months.

8. However, the wholesale pipeline is invariably treated differently from the (primarily) retail pipeline. The latter is estimated to obtain a spares requirement (initial spares). When it is considered at all, the wholesale pipeline is treated as a leadtime. The spares requirement is advanced in time by the wholesale leadtime to obtain a procurement estimate. This step is usually omitted in cost analysis. One reason for this is that neither initial spares, the sum of Cell I and Cell II, nor replenishment spares, the sum of Cell III and Cell IV, are affected. Another reason may be that initiating a procurement does not coincide with incurring a cost.

9. Applying wholesale leadtimes to a time-phased requirement estimate for initial spares produces a time phased procurement estimate for initial spares. It is easy to partition the procurement estimate into portions; one occurring before IOC+2 (Cell I) and the other after IOC+2 (Cell II).

Procurement of Spare and Repair Parts:

	Before IOC+2	After IOC+2	Cost Analysis Terms
Pipeline Fill	Cell I	Cell II	Initial Spares
Consumption	Cell III	Cell IV	Replenishment Spares

D. **The Cost Analysis Perspective, Recapitulation.**

    1. It may be useful to review the relationships established up to this point. The diagram we have been using shows the procurement of spare and repair parts. Cells I and II are pipeline fill. It is equivalent to the cost analysis concept initial spares which is classified as an investment cost. Cells III and IV are consumption. It is equivalent to the cost analysis concept replenishment spares which is classified as an Operating and Support (O&S) cost. One reason why the diagram is an integrated analysis is that it is exhausted by the sum of investment and O&S costs and it displays them without omission or double counting.

    2. Properly estimating life cycle costs is the main emphasis of cost analysis. The time phasing of costs has a somewhat lesser role. Costs in earlier years may be given more emphasis than cost for later years; however, the date IOC+2 years has no special significance. The cost analyst sees no reason to segregate costs between those occurring before and those occurring after IOC+2 years.

Procurement of Spare and Repair Parts:

	Before IOC+2	After IOC+2	Cost Analysis Terms
Pipeline Fill	Cell I	Cell II	Initial Spares
Consumption	Cell III	Cell IV	Replenishment Spares

E.   Cells I and III, Procurement of Spare and Repair Parts Before IOC+2 Years.

1.   Cells I and III constitute the total procurement of spare and repair parts for an initial period of time. It is composed of two elements which are distinct both conceptually and mathematically. One element is (primarily retail) pipeline fill (Cell I). It is a function of the incremental number of end-items deployed. The other element is consumption (Cell III). It is a function of the cumulative number of end-items deployed. Cells I and III are procurement rather than requirements estimates. Requirements estimates are advanced in time by wholesale leadtimes in order to obtain procurement estimates. In the further course of the discussion, these points will be amplified and various logistics documents will be referenced in order to show congruence between the categories already developed and logistics policy.

2.   Why has the total procurement estimate been partitioned into two portions, one occurring before and one after IOC+2 years? The answer is that at IOC+2 the Materiel Readiness Command (MRCs) have completely switched their estimating data base. Prior to IOC+2, maintenance factor average monthly demands are used; after IOC+2 only actual historical average monthly demands (AMDs) are used.

3.   Demands are orders placed on the wholesale supply system (Materiel Readiness Commands and Depots) by the retail supply system. Maintenance factor average monthly demands are engineering estimates, often based on an analogy with other end-item systems. Actual AMDs are calculated from historical data for the end-item system in question.

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4. Once two years of reliable historical demand data has been accumulated, Materiel Readiness Commands (MRCs) will rely on it exclusively. Prior to this time, MRCs will rely in part on maintenance factors. The method of transitioning between the two data bases is given in AR 710-1 (p 4-12.2) [13] and DODI 4140.42 (Inclosure 4 p.2) [14]. It requires that maintenance factors be used exclusively prior to IOC + 6 months. Thereafter a weighted average of maintenance factors and historical AMDs will be used. The weight given to historical AMDs increases by 25% every 6 months until IOC+2 years when a 100% weight is given to actual AMDs.

5. The time from IOC to IOC+2 years is called the demand development period (DDP). (The DDP is defined in AR 700-18 p 5-2 and glossary p.1) [15]. By the end of the DDP, two years of actual demand data has accumulated. A moving average of two years of demand data will be used as the basis for requirements computation from this time onward.

6. During and prior to the DDP the requirement for spares is highly uncertain. The main reason for this is that two years of reliable demand data does not exist. Another reason is that wholesale leadtimes have yet to be experienced for the parts in question. Item records are built and refined, and assumptions concerning repair are made and tested during this time. After the DDP (IOC+2), the supply system has more experience and can better estimate the requirement for spare and repair parts for a new end-item system.

7. Given this perspective, it is small wonder that the period before IOC+2 years is treated differently from the period which follows. A

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review of logistics literature, cost analysis experience with logistical

models such as BBSIP and SESAME [16]   [17] , and my own experience as an

item manager lead me to conclude that Cells I and III taken together

constitute initial provisioning as it is understood by logisticians. Usually

this view is implicit but occasionally it is made explicit. For example, DODI

4140.42, Determination of Initial Requirements for Secondary Item Spare and

Repair Parts, states in its introductory paragraph:

"PURPOSE. This Instruction establishes Department of Defense (DOD) policy in

support of the basic objectives and policies stated in DOD Directive 4140.40

[18] relative to stockage criteria and the determination of requirements for

secondary item spare and repair parts beginning with initial provisioning and

continuing through the demand Development Period (DDP). (Underlining added

for emphasis.)"

    And AR 710-1, Centralized Inventory Management of the Army Supply System

states even more clearly:

    "An item will be treated as a provisioning item and stratified accordingly

as long as it is in the Demanded Development Period (DDP). The DDP will end

after the timeframe IOC+24 months. However, the DDP may be ended earlier if

historical data based on actual demands are representative of future

requirements. In any event once the DDP has ended the secondary item will

migrate from provisioning to a replenishment item."

Procurement of Spare and Repair Parts:

	Before IOC+2	After IOC+2	Cost Analysis Terms
Pipeline Fill	Cell I	Cell II	Initial Spares
Consumption	Cell III	Cell IV	Replenishment Spares
Logistics Terms	Initial Provisioning		

8.   DARCOM-P 700-10 [19] , Logistics Provisioning Techniques, discusses initial provisioning more fully than most other sources. It refers to the initial provisioning estimate as the Total Gross Replenishment Quantity (TRQ) (#64 Appendix C Page 11). It equates this to the sum of Initial Issue Quantity (IIQ), Wholesale Gross Replenishment Quantity (WRQ), and Special Requirements Quantities (SRQs). The IIQ is very similar to Cell I. The WRQ is very similar to Cell III. (Surprisingly, the term replenishment is used above in the normal cost analysis sense and not the normal logistical sense. Usually replenishment means other-than-initial-provisioning to a logistician; hence, it refers to Cells III and IV.) Special Requirements Quantities are, as the name suggests, special requirements and do not alter the general conclusions being developed. Full definitions of IIQ (similar to Cell I) and WRQ (similar to Cell III) are reproduced below:

Initial Issue Quantity (IIQ)	Represents an estimate of the total initial allowance quantities (IAQ) to be available for retail level stockpoints prior to or concurrent with the deployment of operational units of program.
Wholesale Gross Replenishment Quantity (WRQ)	That quantity, exclusive of retail quantity, of the support item which the issuing command anticipates will be required for replenishment from the cognizant supply activity. It is intended to satisfy recurring retail demands.

9. Initial provisioning is a procurement rather than a requirement estimate. In terms of a time-phased estimate, it deals with the question: when should a buy be initiated? rather than the question: when does the Army need to receive materiel? A requirement estimate is advanced in time by wholesale leadtimes in order to obtain a procurement estimate. If the wholesale leadtime is greater, more of the procurement estimate will occur before IOC+2 years and the initial provisioning estimate will be larger.

10. The current policy is to use a wholesale leadtime which is equal to the sum of the procurement leadtime and a 3 month procurement cycle/ safety level. In fact, the sum of a representative procurement cycle and safety level is more than 3 months but current policy attempts to hedge against the risk of overprocurement (DODI 4140.42 page 2). This causes problems for those who try to estimate and time-phase life cycle costs. At some time a longer procurement cycle (also known as an economic order quantity) and safety level will come into play. The transition between leadtimes is not dealt with by existing policy. Another question concerning the application of wholesale leadtimes is whether a full economic order

quantity should be used. Assets fluctuate between a reorder point and a requirements objective. The average level of assets should equal the reorder point and one half of the economic order quantity. Hence, it seems to me that the appropriate wholesale leadtime is equal to the procurement leadtime plus the safety level and one half of the economic order quantity. These questions deserve further consideration because they affect the magnitude of the initial provisioning estimate.

11. Unlike the situation with initial spares, it does not make sense to apply an initial provisioning factor (a percentage) to end-item production cost in order to obtain an initial provisioning estimate. It is easy to see this by conducting the following thought experiment. Suppose an end-item production program is initially 6 years long and that the production quantity is then doubled by continuing the program an additional 6 years. Production costs in constant dollars can be expected to nearly double (taking learning theory into account). If a factor is used it would result in a doubling of the initial provisioning estimates. However, the initial provisioning estimate, the cost of spare and repair parts procured before IOC+2 years, should be unchanged. Clearly an initial provisioning factor is inappropriate as it does not take production schedules into account.

12. Cells I and III constitute initial provisioning. However, there is one important exception for aircraft systems and this is in the case of whole engine spares. It is dealt with DODI 4230.4, Standard Method for Computation of Spare Aircraft Engine Procurement Requirements [20]. Aircraft engines are secondary items. However because of their high unit

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cost, they are treated differently from other secondary items. In fact whole engine spares are treated, in many ways, like major end items. Procurement of whole engine spares is included in initial provisioning regardless of the time of their purchase. This exception will be ignored in further discussions for the sake of methodological simplicity but it is important to individuals who are directly involved in budget preparation.

Procurement of Spare and Repair Parts:

	Before IOC+2	After IOC+2	Cost Analysis Terms
Pipeline Fill	Cell I	Cell II	Initial Spares
Consumption	Cell III	Cell IV	Replenishment Spares
Logistics Terms	Initial Provisioning		

F.   Standard Initial Provisioning.

1.   In the past many provisioning methods existed. Over time a standard initial provisioning (SIP) method has developed. Some important documents which explain SIP are DODI 4140.42, Determination of Initial Requirements for Secondary Item Spare and Repair Parts, AR700-18, Provisioning of U.S. Army Equipment and AR 710-1, Centralized Inventory Management of the Army Supply System. These documents outline SIP by the MRCs. Many aspects of SIP have been automated and are known as Automated Requirements Computation

System Initial Provisioning (ARCSIP). ARCSIP requires vast amounts of data. In order to obtain budgetary estimates early in the life cycle, before all the data required by ARCSIP have been amassed, Bare Bones SIP (BBSIP) was developed. More recently the Selected Essential - Item Stockage for Availability Method (SESAME) was developed. SESAME is similar to BBSIP in purpose but is more advanced and provides an estimate of supply availability as one of its outputs. SESAME is currently the prescribed method for developing initial provisioning budget estimates early in the life cycle. The possibility exists that there may be disconnects between initial provisioning estimates made at different stages of the life cycle.

    2.   SESAME is often used by PMOs to develop their initial provisioning estimates. These estimates are included in many cost estimates, including BCEs. The estimates are often mistakenly displayed under cost element code 2.09, initial spares.

    G.   <u>Cells II and IV, Procurement of Spare and Repair Parts After IOC+2 Years</u>.

    1.   Cells II and IV constitute the total procurement of spare and repair parts after IOC date plus two years. It is composed of two elements which are distinct both conceptually and mathematically: pipeline fill (Cell II), a function of the incremental number of end items fielded; and consumption (Cell IV), a function of the cumulative number of end items fielded. Once the total density of end items has stabilized, there will be no additional pipeline fill. By way of contrast, consumption will obtain its maximum value at this time.

2. Cells II and IV correspond to the logistician's concept of replenishment spares. Replenishment spares estimates are supported by a 24 month moving average of monthly demands. Logisticians need not make a replenishment spares estimate for the end-item's entire life cycle. Instead they use data which is updated monthly to determine whether a given item should be purchased this month and, if so, what quantity must be purchased. This requires forecasting demands throughout the months of the requirements objective. Forecasting is also required to support budget submissions for the Program Objective Memorandum (POM). Considering procurement leadtimes and the five years of the POM budget, forecasts go (roughly) seven years into the future. This, however, is far less than 20 year Operating & Support phase that is typically used by the cost analyst.

Procurement of Spare and Repair Parts:

	Before IOC+2	After IOC+2	Cost Analysis Terms
Pipeline Fill	Cell I	Cell II	Initial Spares
Consumption	Cell III	Cell IV	Replenishment Spares
Logistics Terms	Initial Provisioning	Replenishment Spares	

H.   The Logistics Perspective, Recapitulation.

1.   The diagram we have been using shows the procurement of spare
and repair parts. Cells I and III comprise that portion for which the
procurement decision must be made before IOC+2. These decisions must be made
without the benefit of stable, historical average monthly demands. The sum of
Cells I and III is equivalent to the logisticians concept of initial
provisioning.

2.   Cells II and IV are procurement of spare and repair parts after
IOC date plus two years. During this time procurement decisions will be based
upon a two year moving average of _historical_ monthly demands for each
particular item. Estimates made during this time are more reliable than
estimates made during the demand development period during which initial
provisioning takes place. Cells II and IV correspond to the logisticians'
concept of replenishment spares, a category which logisticians need never
estimate in its entirety.

Procurement of Spare and Repair Parts:

	Before IOC+2	After IOC+2	Cost Analysis Terms
Pipeline Fill	Cell I	Cell II	Initial Spares
Consumption	Cell III	Cell IV	Replenishment Spares
Logistics Terms	Initial Provisioning	Replenishment Spares	

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I.   Initial Provisioning and Initial Spares Contrasted.

1.   Cost analysis is performed primarily for decision making, to
compare estimates over time, and for budgeting. The first function requires
that cost analysis include all the years of a program's life cycle. The
second function requires uniform definitions of cost categories. Cost
analysis for decision making is usually required very early in a program's
life cycle. The cost analysis categories of initial spares (Cells I and II,
pipeline fill) and replenishment spares (Cells III and IV, consumption) have
been constructed with the objectives of conceptual and mathematical simplicity
and the calculation, made at a particular point in time, of the entire life
cycle cost of spare and repair parts. Initial spares is an Investment cost;
replenishment spares is an Operating and Support cost. From a cost analysis
perspective there is no reason to dichotomize the time-phased cost estimate
about a particular point in time, viz., IOC date plus two years.

2.   Logistical concerns include the determination of what items are
to be purchased, when they will be purchased, and the quantity to be
purchased. Associated with this is budgeting for the near term. Estimates
are made for a few years at a time, are frequently updated and support
immediate acquisition and near term budget decisions. The distinction between
pipeline fill and consumption, which is so important for standard cost
reporting in cost analysis, is irrelevant to logisticians for whom "a spare is
a spare is a spare" regardless of whether it is initial or replenishment.
Because logistical estimates have a comparatively shorter time horizon and are

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frequently updated, changing reliability of the forecasting data base is very important. Simply put, the risk of over or under stockage is greater during the demand development period (before IOC+2) than at any other time due to the lack of stable, historical average monthly demands. Consequently, estimates made during and for the demand development period (Cells I and III, initial provisioning) are categorized and funded differently from estimates made during and for later years (Cells II and IV, replenishment spares).

3.   Often initial spares and initial provisioning have been mistakenly treated as synonyms. Cost analysts and logisticians have frequently thought mistakenly that they referred to the same concept when using the term replenishment spares.
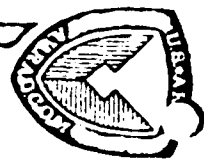
4.   Initial provisioning equals Cells I and III; initial spares equals Cells I and II. Since Cell I is common to both estimates, the difference is between Cell III, consumption prior to IOC+2, and Cell II, pipeline fill after IOC+2. Consumption, which is a function of the cumulative number of end items fielded, is apt to be small prior to IOC+2 because few end items have been fielded. The magnitude of pipeline fill after IOC+2 is highly dependent on the deployment schedule of the end-item. Production and deployment schedules are often about 15 years in duration for helicopter systems (Black Hawk, CH-47). In such cases pipeline fill after IOC+2 is far greater than consumption prior to IOC+2 and, as a result, initial spare estimates are far greater than initial provisioning estimates. For end items with short deployment schedules (as was envisioned in the 1981 ICE for the RPV), pipeline fill after IOC+2 may be less than consumption prior to IOC+2

and, as a result, initial spares estimates will be less than initial
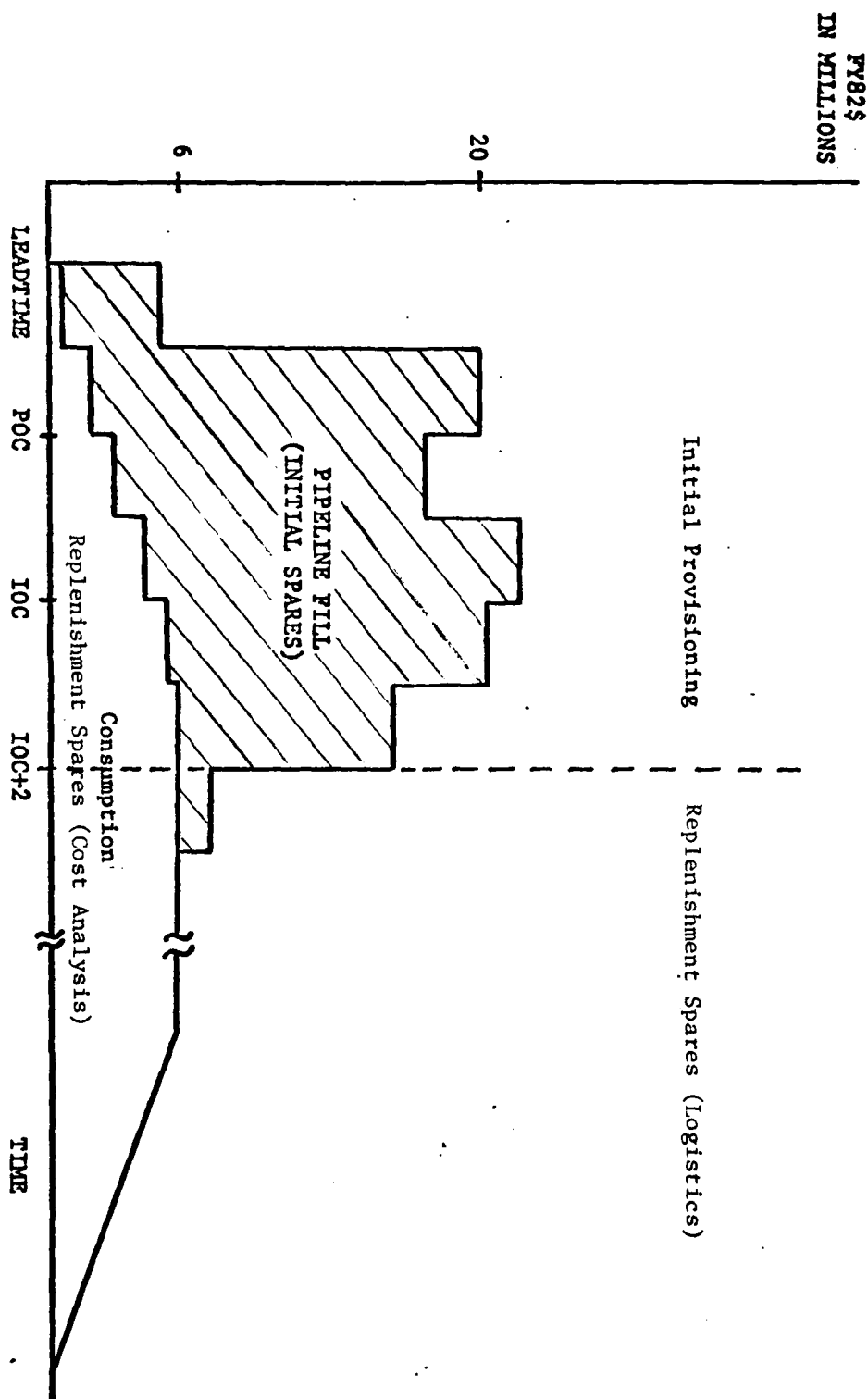provisioning estimates.

     5.   As a general rule, an initial spares estimate will be greater
than an initial provisioning estimate – holding data inputs and all (other)
aspects of the estimating method constant. The RPV program is an exception
due to its short deployment schedule. A diagrammatic presentation, taken from
the May 1981 BCE, is shown on the next page. [3/]

     6.   Appendix A contains a cost data sheet for Initial Spares and
Repair Parts. It shows the definition used in the May 1981 RPV BCE. (It is
for the airframe only. Other cost data sheets and all variable explanation
sheets have been omitted: the former are redundant and the latter do not
apply to the issues contained in this report.) Appendix B provides the
derivation of an Initial Provisioning estimate based on Initial Spare and
Replenishment Spare estimates. It is reproduced from the May 1981 RPV BCE.

FOOTNOTE: [3/] Cost data pertaining to the RPV System are both historical
and obsolete. These cost estimates have been superseded by later RPV BCEs
but are included only to demonstrate the impact of different spares
definitions and should not be used for any other purpose.

RPV BCE INVESTMENT
INITIAL SPARES METHODOLOGY

FY82$
IN MILLIONS

Initial Provisioning

Replenishment Spares (Logistics)

PIPELINE FILL
(INITIAL SPARES)

Consumption
Replenishment Spares (Cost Analysis)

LEADTIME   POC   IOC   IOC+2   TIME

20   6

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VI. RECOMMENDATIONS.

A. Introduction. As stated earlier, the presence of two concepts produces confusion and lost manhours at a minimum, and can result in over or under budgeting, excessive or inadequate stockage and life cycle costs estimates that are too high or too low. (These issues have recently received HQDA visibility. See Appendix C.) There is no need for such problems. The text has presented an integrated spares analysis which, it is believed, satisfies the needs of both logisticians and cost analysts. Both logisticians and cost analysts should learn the other's language and reconcile it to their own. Two recommendations toward this end are provided below:

B. Common Spares Definitions.

1. It is recommended that Department of the Army (DA) adopt one set of spares definitions that would be common to logistics and cost analysis. They should be based upon the following: The initial provisioning cost estimate is the estimated cost of spare and repair parts for which procurement will be initiated before the IOC date plus two years. It is composed of both pipeline fill and consumption, and: The replenishment spares cost estimate is the estimated cost of spare and repair parts for which procurement will be initiated after the IOC date plus two years. It is composed of both pipeline fill and consumption.

2. These definitions would be incorporated in DA Pamphlets 11-3, Investment, and 11-4, Operating and Support. This would cause cost analysts to develop estimates that are consistent with logistics and budget concepts

presented in DODD 4140.40, DODI 4140.42 and AR 710.1. The sum of initial

provisioning and replenishment spares, as defined above, would correctly

represent the life cycle cost of spares.

C. Greater Visibility of Pipeline Fill and Consumption Estimates.

Logistics programs for initial provisioning or replenishment spares do not

always display pipeline fill and consumption. Pipeline fill and consumption

are conceptually and mathematically distinct. Pipeline fill is a function

of the incremental number of end-items fielded in a given year, whereas

consumption is a function of the cumulative number of end items fielded by

a given year. These two components should be computed separately and then

summed to obtain either an initial provisioning or a replenishment spares

estimate. Display of these subtotals would facilitate comparison of one

inventory model to another and of inventory models to actual experience.

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1.   AR 700-18, Provisioning of US Army Equipment. Washington, DC: Headquarters Department of the Army, September 1981.

2.   Department of the Army Pamphlet No. 11-3, Investment Cost Guide for Army Materiel Systems. Washington, DC: Department of the Army, Office of the Comptroller, April 1976.

3.   Baseline Cost Estimate CH-47 Modernization Program. St. Louis, MO: CH-47 Modernization Program Project Manager's Office, June 1980.

4.   Inventory Research Office Technical Report No. 242, Bare Bones: A Method for Estimating Provisioning Budget Requirements in the Outyears. Philadelphia, PA: US Army Inventory Research Office, July 1977.

5.   Independent Cost Estimate CH-47 Modernization Program. St. Louis, MO: US Army Aviation Research and Development Command, Directorate for Plans and Analysis, June 1980.

6.   Life Cycle Cost Estimate for the Utility Tactical Transport Aircraft System (UTTAS) Cost and Operational Effectiveness Analysis (COEA). St. Louis, MO: US Army Aviation Research and Development Command, Directorate for Plans and Analysis, October 1980.

7.   BLACK HAWK Baseline Cost Estimate. St. Louis, MO: BLACK HAWK Project Manager's Office, September 1979.

8.   BLACK HAWK Selected Acquisition Report. St. Louis, MO: BLACK HAWK Project Manager's Office, December 1980.

9.   Remotely Piloted Vehicle Baseline Cost Estimate. St. Louis, MO: Remotely Piloted Vehicle Project Manager's Office, February 1981.

10.   Remotely Piloted Vehicle Independent Cost Estimate. St. Louis, MO: US Army Aviation Research and Development Command, Directorate for Plans and Analysis, February 1981.

11.   Remotely Piloted Vehicle Baseline Cost Estimate. St. Louis, MO: May 1981.

12.   Department of the Army Pamphlet No. 11-4, Operating and Support Cost Guide for Army Materiel Systems. Washington, DC: Department of the Army, Office of the Comptroller, April 1976.

13.   AR 710-1, Centralized Inventory Management of the Army Supply System. Washington, DC, December 1970.

14. DOD Instruction 4140.42, <u>Determination of Initial Requirements for Secondary Item Spare and Repair Parts</u>. Washington, DC, August 1974.

15. AR 700-18, <u>Provisioning of US Army Equipment</u>. Department of the Army, Washington, DC, September 1981.

16. DARCOM-P 700-18, <u>Users Guide to Selected Essential - Item Stockage for Availability Method (SESAME)</u>. Alexandria, VA: US Army Materiel Development and Readiness Command, March 1980.

17. IRO Technical Report 80-2, <u>Mathematics for Sesame Model</u>. Philadelphia, PA: US Army Inventory Research Office, February 1980.

18. DoD Directive 4140.40, <u>Basic Objectives and Policies on Provisioning of End Items of Materiel</u>. Washington, DC, August 1974.

19. DARCOM-P 700-10, <u>Provisioning Techniques</u>, Alexandria, VA: US Army Development and Readiness Command, January 1981.

20. DoD Instruction 4230.4, <u>Standard Method for Computation of Spare Aircraft Engine Procurement Requirements</u>. Washington, DC, July 1971.

21. Boxx, James P., <u>Analysis of Provisioning Methods and Procedures</u>, Research Report. St. Louis, MO: US Army Aviation Systems Command, September 1976.

APPENDIX A

INITIAL SPARES AND REPAIR PARTS -

COST DATA SHEET, REMOTELY PILOTED VEHICLE (RPV)

BASELINE COST ESTIMATE (BCE)

MAY 1981

Cost data pertaining to the RPV System are both
historical and obsolete. These cost estimates have
been superseded by later RPV BCEs but are included
only to demonstrate the impact of different spares
definitions and should not be used for any other
purpose.

COST DATA SHEET

ITEM: Initial Spares and Repair Parts - Airframe

COST DATA EXPRESSION:

Cost (2.09,1) = This element includes the cost of filling the (primary retail) supply pipeline with spare components, subassemblies and repair parts for newly fielded Remotely Piloted Vehicle platoons. This is a one-time cost for each platoon fielded.

INCLUDES:

Initial spare and repair parts for Active Army and training base platoons and for War Reserve.

EXCLUDES:

The continuing cost of spare and repair parts due to consumption.

FINAL COST MODEL EXPRESSION:

$$\text{Cost } (2.09,1) = [(IS[1] \times IS[2]) + (IS[3] \times IS[5])] \times ER[2]$$

$$= [(30.9 \times .01) + (75.5 \times .1892)] \times 1.03646$$

$$= [.309 + 14.284] \times 1.03646$$

$$= \$15.125\overline{M}$$

VARIABLES ARE:

IS [1] = Production cost for airframes intended for War Reserve stockage = $30.9\overline{M}$

IS [2] = Spare parts factor for War Reserve = .01

IS [3] = Production cost for airframes intended for active use = $75.5\overline{M}$

IS [5] = Spares factor .1892

ER [2] = FY79-82 Spares Escalation Differential = 1.03646

APPENDIX B

INITIAL PROVISIONING -

ANNEX TO THE REMOTELY PILOTED VEHICLE (RPV)

BASELINE COST ESTIMATE (BCE)

MAY 1981

Cost Data pertaining to the RPV System are both
historical and obsolete. These cost estimates have
been superseded by later RPV BCEs but are included
only to demonstrate the impact of different spares
definitions and should not be used for any other
purpose.

ANNEX TO THE APRIL 1981 REMOTELY PILOTED VEHICLE (RPV) BASELINE COST ESTIMATE
- INITIAL PROVISIONING

Initial provisioning is a logistics and budget term. It includes all the spare and repair parts that must be purchased prior to two years after the Initial Operational Capability (IOC) date. After IOC plus two years, two years of reliable demand experience will have been accumulated and the regular (demand-based) supply system will be able to operate. Initial provisioning includes both pipeline fill and consumption of spare and repair parts.

Pipeline fill (Initial Spares) occurs throughout the production and deployment of the end item. However, initial provisioning includes only that portion of initial spares which, after considering leadtimes, should be purchased before IOC plus two years.

If the deployment schedule is compact, a large portion of the initial spares will be included in initial provisioning. This is the case for the RPV system which is deployed in six years. If the weapon system has a prolongued deployment schedule (e.g. 15 years for the Black Hawk and 14 years for the CH-47 Modernization Program) a small portion of the initial spares will be included under initial provisioning.

As a result, traditional rules of thumb for initial spares may not apply for initial provisioning. For example, if one believes that initial spares should be around fifteen percent of production cost, this should not be applied without modification to initial provisioning. The initial provisioning estimate might run from five percent to twenty percent depending on the deployment schedule. Further research or experience would be required to know the true range of percentages.

This addendum provides the initial provisioning estimate for the preferred alternative. The initial provisioning estimate includes both pipeline fill and consumption. The derivation of the pipeline fill estimate can be found under cost element code 2.09 (Initial Spares). The consumption estimate is the sum of cost element codes 3.021 (Replenishment Spares), 3.032 (Depot Materiel), 3.0523 (Replacement of Major Common TOE Equipment) and 3.0524 (PEMA Repair Parts and Secondary Items). 3.0523 and 3.0524 are 58.26% of 3.052, Other Direct.

The pipeline fill and consumption estimates are summed for each fiscal year to obtain the estimated requirement for spare and repair parts. To derive a procurement estimate, one must consider inventory management procedures used by the Materiel Readiness Commands. The requirement for spare and repair parts is advanced by leadtimes and multiplied by a factor which takes into account various non-leadtime supply elements (safety level and economic order quantity) which increase procurement and stockage.

The initial provisioning estimate is the procurement estimate prior to IOC date plus two years. IOC date for the RPV system is September 1985. Hence, initial provisioning extends thru FY87. The initial provisioning estimate for the preferred alternative is $105.022\overline{M}$ in constant FY82 dollars and $134.978\overline{M}$ in escalated dollars. The derivation is shown below:

Preferred Alternative   FY 82 $ $\overline{M}$

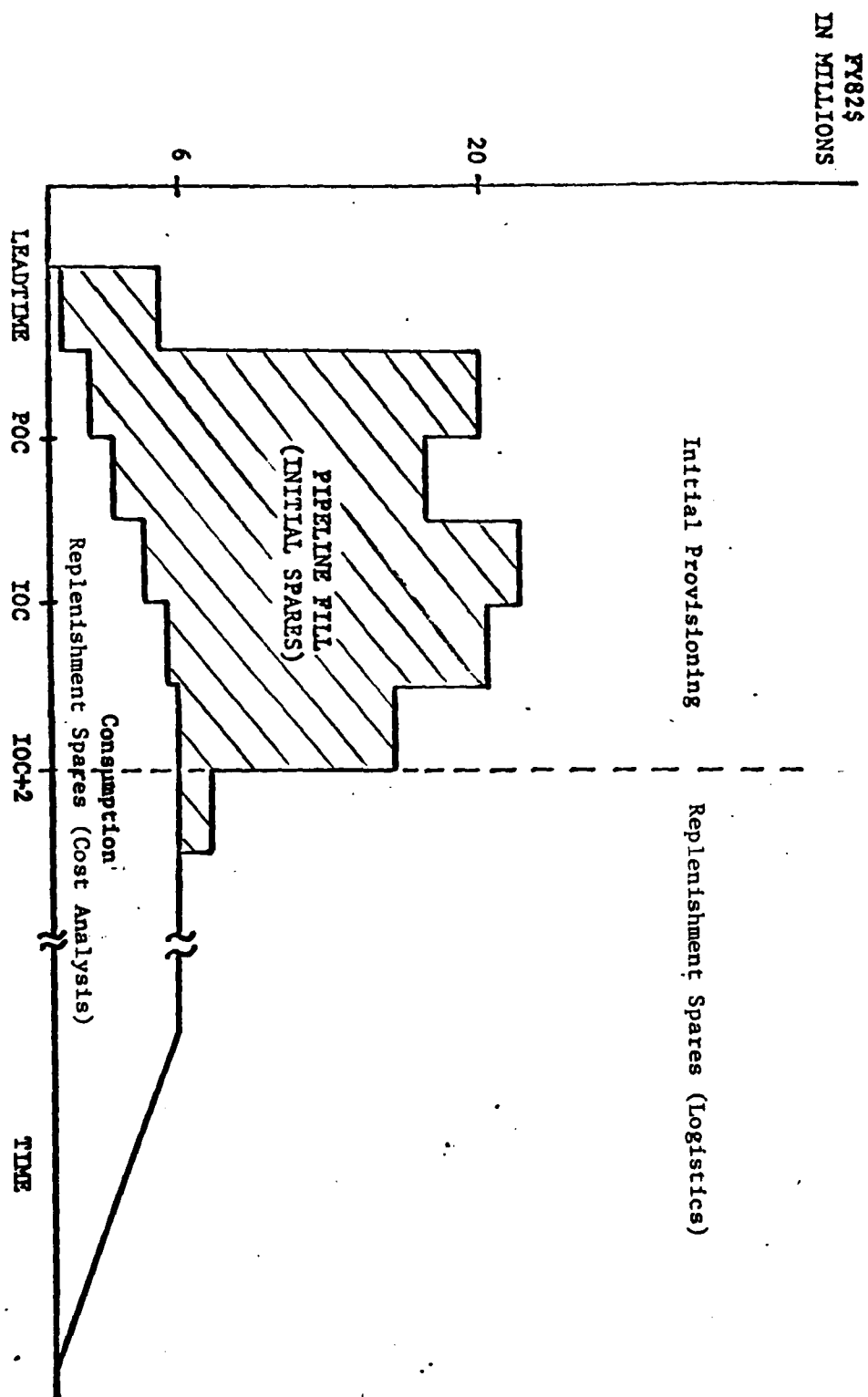| FY	Pipeline Fill (Initial Spares)	Consumption	Total	Procurement Note 1)	Adjusted Procurement (Note 2)
82				4.8357	5.0577
83				19.7685	20.6760
84	4.654	.7190	5.373	16.7384	17.5068
85	19.560	1.8080	21.368	20.9312	21.8920
86	13.316	2.9080	16.224	19.3599	20.2486
87	17.036	4.4182	21.4542	15.2467	15.9466
88	13.590	5.5372	19.1272	6.7884	7.1000
89	8.919	5.8965	14,8155	5.8965	6.1672
90	0	5.8965	5.8965	5.8965	6.1672
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.

The total adjusted procurement estimate prior to IOC date plus two years (thru FY 87) is 101.3277. Multiplying this by the FY 79 - 82 Spares Escalation differential factor 1.03646 (see ER[2]) gives an FY82 estimate of 105.0220. This is also the initial provisioning estimate.

Note 1. The procurement estimate is based on a 22.8 month leadtime composed of .5 months requirements determination time, 5.1 month administrative leadtime, 17.2 months production leadtime. The value of these supply elements comes from the 30 September 1980 Stratification of Assets - PA Secondary and Stock Fund items, TSARCOM.

Note 2. This adjustment is made to reflect additional procurement for a .9 month safety level and 2.35 month of assets which represents one half of a representative economic order quantity. For the source of these supply elements see note 1.

INITIAL SPARES METHODOLOGY

FY82$
IN MILLIONS

20

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Initial Provisioning

Replenishment Spares (Logistics)

PIPELINE FILL
(INITIAL SPARES)

Consumption
Replenishment Spares (Cost Analysis)

LEADTIME

POC

IOC

IOC+2

TIME
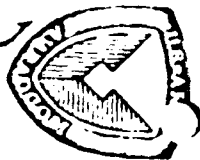
APPENDIX C

MEMORANDUM FOR THE DIRECTOR OF COST ANALYSIS,
COMPTROLLER OF THE ARMY, SUBJECT: DEFINITIONS
OF INITIAL SPARES AND REPLENISHMENT SPARES,
APRIL 1983

DRDAV-BE   12 April 1983

MEMORANDUM THRU DIRECTOR OF PLANS AND ANALYSIS, USAAVRADCOM

FOR THE DIRECTOR OF COST ANALYSIS, COMPTROLLER OF THE ARMY

SUBJECT: Definitions of Initial Spares and Replenishment Spares

1. For as long as I can recall, at least going back to 1971, I have per-
ceived a different definition between the terms "Initial Spares", as used
in the cost analysis community, and "Initial Provisioning", as used pri-
marily in the logistics community. It now appears that this age old
definition problem is a principal contribution to what I see as a major
miscalculation of spare and replenishment parts cost, if BCEs use the
"Logistics World" definitions in investment cost estimating without
changing our O&S definitions.

2. To get down to cases, the facts I have uncovered or discovered and
resulting questions are:

    a. Some BCEs are using the SESAME output for "Initial Spares" in our
Investment Cost as defined by our Army Pamphlet 11-3.

    b. My inquiry into the SESAME process reveals that the time frame
scope is IOC plus two years.

    c. However, in most weapons procurements, certainly in aircraft pro-
curement scenarios, IOC plus two may not come close to accounting for the
total fleet to be procured and eventually deployed. Consequently, if
"Initial Spares" in our BCEs covers only IOC plus two years, where is the
cost estimate for spares to be procured during the remaining years of the
procurement cycle? As more systems are procured and deployed at various
worldwide locations, parts and components will have to be procured also
and be deployed at the organization sites and intermediate maintenance
sites.

3. In summary, a decision to use a SESAME output, based on IOC plus two
years for initial spares in the investment phase of our life cycle cost
estimates, seems to represent a major and serious understatement of spares
requirement. There are some voices that seem to imply that the understate-
ment, with which I am concerned, does not exist due to the belief that the

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DRDAV-BE   12 April 1983
SUBJECT: Definitions of Initial Spares and Replenishment Spares

O&S segment of our life cycle picks up this additional stockage of spares
and components. This is not true, as O&S cost by our DA Pamphlet defini-
tion only accounts for <u>consumption</u> of parts, not initial stockage of parts.
I feel there are further complications in "cross walking" our BCEs to the
budget process in the initial spares and the O&S area, but the problems can
usually be solved, if semantics/definitions are addressed first.

4. I realize that I may not have vision of all the facts and perhaps there
is some compensating process in the budget cycle. However, in my mind, the
issue may need immediate focus, and even though I do not have access to all
of the budget input, I feel compelled to go on record with these basic
concerns, trusting they will be accepted as a positive concern and not
negativism.

                              G. NORMAN STANARD
                              Chief, Estimates and Studies Division

CF:
DARCOM, DRCCP-E

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FILL PIPELINE

CONSUMPTION - PIPELINE FLOW

	IOC + 2	IOC + 2 TO END PROCUREMENT	END PROCUREMENT TO END O&S

LOGISTICS

COST ANALYSIS

INITIAL PROVISIONING, I & III - SESAME

INITIAL SPARES, I & II

REPLENISHMENT SPARES, III & IV & V - AMOS

IF USE SESAME FOR INVESTMENT COSTS & AMOS FOR O&S COSTS IN BCE, THEN:
1) DOUBLE ACCOUNT FOR III
2) EXCLUDE II

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MEL

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